THE CONCEPT OF "DYNAMIC" CONSCIOUSNESS

By

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INTRODUCTION

THE nature of consciousness is a central theoretical problem for psychology, psychiatry and psychosomatic medicine. Attempts to deal with this problem in these fields have led to precarious relationships with philosophy on the one hand and with neurophysiology on the other. The result is both conceptually and semantically unsatisfactory. For example, is "consciousness" to be taken to mean some general state or level of awareness which is capable of being altered or reduced? Or is there no general consciousness but only states of being conscious of specific things? This paper discusses some of the philosophical problems involved in the term "consciousness" and outlines ways in which recent neurophysiological advances have contributed to clinical knowledge about the general or specific nature of consciousness.

PHILOSOPHICAL ASPECTS

Most of the difficulties concerning the term "consciousness" have arisen from its introspectionist origins. William James, for example, in the introduction to his *Principles* (1890) makes the introspectionist approach a dogma when he states:

> "Introspective observation is what we have to rely on first and foremost and always. The word 'introspection' needs hardly to be defined—it means of course looking into our own minds and reporting what we there discover. Everyone agrees that we there discover states of consciousness. So far as I know the existence of such states has never been doubted by any critic, however sceptical in other respects he may have been. That we have cogitations of some sort is the inconcussum in a world most of whose other facts have at some time tottered in the breath of philosophical doubt. All people unhesitatingly believe that they feel themselves thinking and that they distinguish the mental state as inward activity or passion from all the objects with which it may cognitively deal. I regard this belief as the most fundamental of all the postulates of Psychology and shall discard all curious enquiries about its certainty as too metaphysical for the scope of this book."

In spite of James's enviable certainty, developments in psychology since his day seem to have stemmed from various forms of doubt about this very inconcussum.

There are two kinds of objection to this introspectionist formulation. These can be referred to as the subjectivist fallacy and the fallacy of misplaced concreteness. The former is the metaphysician's objection to the idea of self-consciousness as a cognitive state which has itself as its own object. This is

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held to be a psychological impossibility as every cognitive state must have for its object something other than itself (Baldwin, 1925).

The fallacy of misplaced concreteness appears to be more fundamental. It denotes the objection to ascribing concrete characteristics to an abstraction. Introspection leads us into this error because it makes available to us certain processes or experiences which have characteristics in common. We abstract this common character and call it "consciousness" and subsequently take the original experiences to be "states" or "modifications" of consciousness. This objection is more likely to worry the philosopher than the psychologist or clinician who, in trying to be scientific about consciousness, are dealing with conventions similar to those in the physical sciences. In dealing with things we start from an abstraction of their common property which we term "matter" and then talk as if the things themselves were forms of matter.

The development of the associationist school of philosophy tended to widen the original introspectionist use of "consciousness". For example, Bertrand Russell in his *Outline of Philosophy* (1927) describes consciousness and its operation in the processes of perceiving, involving physical processes external to the body, then processes in the eye, nerves and brain, producing finally a pattern which by the law of association gives rise to tactual and other expectations and images as well as memories and other habits.

> "But everything in this whole series consists of causally continuous change of events in space-time, and we have no reason to assert that the events in us are so very different from the events outside us—as to this, we must remain ignorant since the outside events are only known as to their abstract mathematical characteristics, which do not show whether these events are like thoughts or unlike them."

This point of view allows Russell to state the practical functions of consciousness and thought to be "that they enable us to act with reference to what is distant in time or space, even though it is not at present stimulating our senses" (*Analysis of Mind*, 1921).

The philosophers' process of hardening themselves against the ghostly notion of mind has been carried furthest by Ryle (1949) who rejects the notion of consciousness or of a mind as an entity of some sort, just as brain, a hand or a nose is an entity. Originally mind was thought of as a queer mysterious entity as indicated by the terms which have been used as synonyms, such as soul, ego and psyche. Ryle argues that mind is neither mysterious nor an entity and that, as before, its mystery arises from our tendency to treat an abstraction as though it were concrete. Ryle's treatment of the problem can be summarized in the following simple example.* We know that if we bend a piece of wood sufficiently hard it will break. We can therefore say of this piece of wood that it has a tendency to break. Saying that the wood has a tendency to break is not like saying that a man has a brain, a hand or a nose, for there is no such entity as a "tendency to break". To say that the piece of wood has a tendency to break is merely to state that if certain conditions are fulfilled then it is likely that the wood will break. Ryle suggests that to say that a person has a mind is similar to saying that the wood has a tendency to break. Thus the mind or consciousness is not to be thought of as an entity but as a complex of dispositions. To say that a person has a mind therefore does not mean that in addition to his body there is a ghostly something, i.e. his mind, known only to himself and to

* I am indebted for this example to Professor Smart of the University of Sydney.

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others by hearsay only. It means that his body has a complex set of dispositions to behave in various ways. Thus Ryle can conclude that "mind is not the topic of sets of untestable, categorical propositions but the topic of sets of testable, hypothetical and semi-hypothetical propositions".

This kind of argument is psychologically acceptable and can take us out of philosophy. The psychological version is that we know about the mental capacities of an organism by knowing about the properties of the organism. This however, raises the question of what properties an organism must have to make it appear with any reasonable degree of certainty to be a conscious human being. It is possible to tackle this question without paying attention to the basic mechanisms of the bodily dispositions. For example, Skinner (1938) in his operationist approach deals with the properties of the empty organism and intentionally ignores the nervous system. To Skinner the properties of the organism are simply the ways in which stimulation and response are connected, just as the properties of any electronic instrument are the ways in which the electric output is related to the electric input. However attractive this simple solution may be, Skinner still uses the process of introspection as a psychological property of living human organisms and we are thus brought back to the previously mentioned difficulties of the confusion of consciousness meaning awareness of environment and consciousness meaning awareness of mental processes themselves.

Clinical Aspects

Cobb (1952) on the other hand, ignoring these difficulties and using the term to mean both awareness of environment and of self, holds that consciousness must be something more than response to stimulation because a response can occur at spinal levels at which no awareness is involved. Cobb's argument introduces the neural implications of the bodily dispositions which Ryle attaches to "mind", for he asserts right away that consciousness is a property of the organism in action just as much as contraction is a property of muscle. It is a physiological function and as such is associated with a system of organs—specifically the central nervous system. The central nervous system represents a hierarchy of more and more complex neural mechanisms and consciousness is integrated at many levels, dependent upon the existence of reverberating circuits between cortex and thalamus and relationships between cord, brain stem, hypothalamus, thalamus and cortex. The core of Cobb's argument can be stated in three propositions which he holds to be valid for the contemporary state of knowledge:

(*a*) No biological process occurs without involving a change in structure.
(*b*) Whenever the brain functions there is organic change.
(*c*) The brain is the organ of mind.

We have reached a point at which we have apparently resolved many of the philosopher's problems by an assertion that psychological phenomena such as thinking, knowing, willing are just as much functions of the organism as are walking, excreting, digesting, for there are no other kinds of function—unless supernatural. This may not be an entirely satisfactory position to maintain but it serves to translate the problem into the clinician's field which deals with phenomena related to illness and disease processes.

It might be expected that the neurologist's views on consciousness would arise from an entirely different set of determinants from those of the philosopher. This may not be entirely so, for Riese (1954) claims that Cartesian

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dualism and Evolutionism were the two greatest influences in the development of Hughlings Jackson's and consequently of contemporary neurology. The significance of evolutionary thought seems obvious enough in Jackson's concept of hierarchy and the Cartesian philosophy may have determined his acceptance of a mind-body dichotomy as exemplified in his often quoted assertion that "there is no physiology of the mind any more than there is psychology of the nervous system". Certainly, although from different premises, he arrives at statements which have the characteristic Cartesian stamp of separating subject and object. For example, although the highest cerebral centres were to Jackson the physical basis of consciousness, he postulated that the substrata of consciousness were double. By the nervous arrangements of the right posterior and left anterior lobes he maintained that we learn the nature and position of the object which affects us. The nervous arrangements of the right anterior and left posterior lobes allowed us to learn the manner in which our organism is affected. He further elaborated the distinction between subject and object consciousness by claiming that the activity of the substrata of subject consciousness always preceded that of the substrata of object consciousness which were thus higher in his hierarchy than those of subject consciousness.

From Jackson's work we derive the concept of functional levels in the central nervous system on which we base our ideas of the supremacy of cerebral cortex, equating higher mental processes with higher levels of brain function. In the search for a "location" for consciousness there was a tendency to ignore lower or brain-stem centres as being of subsidiary importance and under the control of the more recently developed cortex.

Head (1926) however did not concentrate only upon higher centres. He held that consideration of lower functional levels of nervous system could throw a light on the nature and significance of consciousness for even in decerebrate preparations such as a spinal cat, for example, a great degree of adaptative behaviour can occur. Head originally developed a concept of vigilance to apply mainly to spinal and mid-brain levels but by analogy it came to refer to the operation of cerebral cortex on the basis that consciousness has the same relationship to the higher nervous centres as purposive reflexes have to lower nervous centres. Vigilance referred to the high-grade state of physiological efficiency of any level of nervous system and "when vigilance is high mind and body are poised in readiness to respond to any event, external or internal, but if it is lowered by injury, want of nutrition, chloroform or any other toxic influence, those high-grade functions may suffer in general or in part whether they are associated with consciousness or not". The last part of this quotation should be stressed to disaffirm that Head equated consciousness with vigilance.

The clinically based approach to consciousness starts from considerations of unconsciousness as a symptom. This negative term presents as many difficulties as the positive term and Jefferson (1944) feels that a new term is needed to define unconsciousness—traumatic or otherwise—which would designate more pointedly its nature and its pathological status in terms of neurophysiology. However, to do this a large number of terms would be required as unconscious patients differ profoundly in respect of such factors as the degree of unconsciousness, whether consciousness is lost fully or only in part, whether it is transient and fleeting or prolonged and involves coma.

Martin (1949) distinguishes two varieties of unconsciousness and disturbed consciousness: (*a*) coma—related to sleep and to depressed cortical activity and (*b*) convulsive—related to irregular cortical discharges. He states that there

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appears to be no evidence of consciousness in man from the activity of other structures in the absence of cortical activity and that an impairment of activity of cortex over a wide area leads to unconsciousness. However, this activity of cortex is maintained in some vegetative fashion by the activity of the hypothalamus and unconsciousness may be caused by lesions of the hypothalamus.

In this Martin seems to be merely restating the view that the activity of the cortex with which consciousness is associated is maintained by afferent impulses in sensory systems. However, he goes on to suggest that consciousness depends not only upon a process in which the cortex is kept in a state of activity by sensory impulses but also by an endogenous activation dependent upon the hypothalamus. The hypothalamus appears to be the driving influence of the cortex and is likened to the electric current which makes the wireless set live. Once the cortex is live it is capable of receiving and of interpreting sensory excitations without which the cortex is silent and consciousness cannot be demonstrated. This means that, although in theory consciousness might be maintained by tactile, olfactory, gustatory, auditory and visual impulses arising from the environment, some excitation from the body itself is essential for the maintenance of consciousness. This modifies the assumption of a direct correspondence between "higher mental processes" and "higher nervous levels". The statement can still be made that consciousness is associated with the activity of the cortex which is of course different from saying that consciousness is an activity of the cortex.

Brain (1950) also suggests that subcortical structures have an important role to play in the maintenance of consciousness:

> "Consciousness is linked with basal nuclei which made their appearance in the course of evolution millions of years before thought became possible, and since the days of our earliest vertebrate ancestors have sustained the life of the feelings."

Statements of this kind which direct attention to the importance of non-cortical structures for consciousness are precursors of the work on the ascending reticular system which originated "with the chance observation that direct electrical excitation of the reticular formation of the brain stem induced changes in the EEG seemingly identical with those observed in awakening from sleep or alerting to attention" (Magoun, 1954). From this chance observation a great deal of work has developed with interdisciplinary significance. Such work is reported currently in an International Symposium of the Henry Ford Hospital (Jasper, 1958) and previously in a symposium sponsored by the Council of the International Organization of Medical Sciences (Delafresnaye, 1954).

The Significance of the Brain-Stem Reticular Formation

The reticular system of the brain stem is an ill-defined anatomical entity, histologically primitive and undifferentiated and well-developed in amphibious animals (Nauta and Whitlock, 1954). In the primates the system acts in conjunction with the diffuse thalamic projections to the cortex (Moruzzi and Magoun, 1949).

Cajal at the beginning of this century had observed significant differences in the reticular cells of the brain stem involving both sensory and motor collaterals and had concluded that not only do such cells have multiple influences operating upon them but even adjacent cells may have entirely different connections (Livingston, 1957). However, by the methods of study then

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available the brain-stem reticular system was generally found to be either unresponsive to stimulation or to yield apparently non-specific patterns of response.

This finding was of course not in keeping with the spirit of neurophysiological research which was until recent times dominated by localization hypotheses and sought more refined knowledge of point-to-point relationships within the nervous system. Magoun (1944) and others working on animals without central anaesthesia began to interest themselves in the functions of the reticular formation which seemed to be widespread in their effects. This led to a distinction within the nervous system between two general divisions—one comprising the "classical" sensory and motor pathways with relatively discrete functions and the other including the brain-stem reticular formation which appeared to have more generalized functions.

Moruzzi (1949), Jasper (1949) and Lindsley (1949) reported electrophysiological, neurophysiological and psychophysiological studies which showed that this brain-stem reticular formation had both a widespread inhibitory effect on spinal motor mechanisms and a generalized facilitatory influence. This latter facilitatory function of the reticular formation was referred to an ascending system of projections which tend to activate the cortex in a generalized fashion.

Further, the reticular formation is capable of modifying central excitatory states in a downwards direction. Livingston (1957) has shown that the cortex projects from certain discrete areas down into the reticular formation producing not only an interaction between descending impulses from the cortex and the sensory input but also an interaction of certain cortical fields with each other. He uses the term "a kind of Grand Central Station for the interaction of impulses generated in remote parts of the nervous system" to describe the complex activity of the reticular formation.

Thus it seems that certain cortical fields can be influenced in their activity by the intrinsic activity of the brain stem and in their turn these individual cortical fields can exert patterns of influence upon this intrinsic activity either by diminishing or augmenting it. The picture is even more complex when the sequence is shown to produce alternations of excitement and depression of such intrinsic activities. As Livingston (1957) puts it:

> ". . . the cortex is not simply the victim of whatever the reticular activating system might demand of it but the cortex itself possesses corticofugal regulating mechanisms which in turn influence the level of activity within the reticular formation."

Evidence for this is supplied from the experiments of Segundo, Arana and French (1955) working in Magoun's laboratories. They have shown that electrical activation of certain cortical fields in monkeys immobilized by curare but free from the influence of central anaesthetic induces the EEG response characteristic of arousal. Also, naturally sleeping monkeys with implanted electrodes in such cortical fields are awakened and aroused behaviourally when stimulation is applied. However, electrical stimulation of cortical sites which do not project to the reticular formation fails to elicit such EEG arousal or behavioural changes even though high intensities of current are applied. It seems therefore that corticofugal projections play a part in activating the rest of the brain via the reticular activating system. This is held to be so, not only in relation to arousal in response to specific stimuli but also for the maintenance of a centrally "aroused" state.

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Investigations of sensory components suggested that the brain-stem reticular formation is also able to influence conduction along sensory paths (Moruzzi, 1956). For some time it has been recognized that recording of EEG changes in response to sensory stimulation was easier from anaesthetized than from unanaesthetized animals. This is attributed to the fact that during anaesthesia the inhibiting action of the reticular formation upon afferent impulses along classical sensory pathways is interrupted. The sensory implications are specifically illustrated in the work of Hernandez-Peon, Scherrer and Jouvet (1956) on unanaesthetized cats with electrodes implanted in the dorsal cochlear nucleus to allow recording of auditory impulses. In the relaxed cat responses to a click could be recorded as a high-amplitude localized electrical discharge. When however some mice in a jar were placed near the cat the amplitude of the discharges in response to the click-stimuli was markedly reduced while the animal's attention was directed to the mice. When the mice were removed and the cat was once more relaxed and inattentive responses to the clicks returned to their previous level.

They also found that if the click-stimulus was repeated and prolonged in the absence of reward or punishment cues the recorded potential was reduced in accordance with the expected sensory adaptation or habituation effect. The interesting theoretical point here is that the psychological assumption that this habituation is perceptually determined is not confirmed as it appears that the sensory pathways, conventionally held to be discrete up to the level of cortex, can in fact be influenced significantly at a level well below cortex by events occurring in the brain stem.

Jung and his colleagues (1958) in Freiburg have used a technique of microelectrode recordings from single neurones to demonstrate that the subcortical non-specific system can exert its effects on single neurones. Their experiments on light vision show that a general state of alertness or arousal can influence the subjective point of flicker fusion. This has significance for an understanding of perception and how excitation is paralleled in subjective experience.

Such a formulation allows the beginning of an appreciation of how the central nervous system can provide some of the neural mechanisms underlying arousal and consciousness. The activity of the reticular activating system seems to be implicated both in the maintenance of "levels" of consciousness and also, because of its capacity for sensory control, in determining the "content" of consciousness.

Discussion

This does not mean that a locus or "seat" of consciousness has been found. This is philosophically unsatisfactory and is no more meaningful than attempting to ascribe the sound from a wireless set to a switch, a valve or a circuit rather than to operations which can be abstracted from all the components of the set. The neurophysiological work on the reticular activating system extends our psychophysiological concepts so that they become more consistent with the complexity we have come to expect from the neural mechanisms underlying our capacity to adapt or our ability in Russell's words "to act with reference to what is distant in time or space even though it is not at present stimulating our senses". This work also suggests that consciousness should be viewed in a scalar or quantitative fashion along a continuum between coma and "clear" consciousness such as is suggested by Delay (1946) in his assertion that what we know as consciousness in man is an extrapolation of the primitive vigilance shared by a large part of the animal kingdom.

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Previous attempts in psychology to formulate a rational basis for the neural mechanism underlying conscious processes have been unsatisfactory in that they have either led to a complete rejection of neurophysiological variables as with Skinner, or of consciousness itself as with the Behaviourists, or to an acceptance of an implicit congruity between psychological and physiological processes as with the Pavlovians. While it may not solve the problem of the "seat" of consciousness, this new neurophysiological approach is a fruitful source of hypotheses and can provide a model of consciousness appropriate to psychology.

A Model of Consciousness

The model of consciousness which can be derived from this work is a system in which complex patterns initiated by an input are controlled by central dominance and in which the direction of this central dominance is determined by some part of the input to the system. Its function in a biological sense is therefore regulatory. In electrical or mechanical terms the system would be a circuit or device whose operation provided a continuous series of equilibria. If we now transfer the regulatory nature of this system to the concept of consciousness itself we can arrive at the notion of "dynamic" consciousness. This term implies that it is no longer appropriate to regard consciousness as passive or epiphenomenal as the conventional stimulus-response approach might suggest.

Although it may be no more than sophistry it is worth while pointing out the paradox that, while we have a concept of dynamic unconscious processes in psychology, we still tend to regard consciousness as a static and intangible quality. The new concepts in neurophysiology can allow us to think of consciousness in more dynamic terms and to say that it is the characteristic whereby an individual's capacity to react adaptively can be maximized. It is akin to such concepts as vigilance, alerting or arousal, although the technical use of these terms does not permit them to be synonyms for consciousness.

The significance of processes of attending in perception parallels the significance of dynamic consciousness for general behaviour in which an adjustment is maintained between the inner processes and environmental change. Hebb (1949, p. 146) makes the point that:

> "The most important mark of consciousness is the continual changing selective responsiveness to different aspects of a familiar environment, the unchanging responsiveness to unusual or unexpected events together with the continual presence of purpose . . . or motor equivalence."

However, the concept which is offered here of dynamic consciousness would stress that it is consciousness itself which provides the essential conditions for varying behaviour in an adaptive fashion.

Starting from the simple statement that the more information available to an individual the more likely is his subsequent behaviour to be adaptive, we can use an analogy between perceiving and statistical methods. The more adequate the information sampled the more likely is the resultant action to be appropriate (Collier, 1955). Consciousness, by this analogy, provides the best possible sampling conditions for any required action. This permits the convention of consciousness as a continuum for it is not always appropriate to take the largest possible sampling which is called for under conditions of extreme novelty or threat. An ordinary everyday level of consciousness can be maintained on perceptual sampling well below the maximum possible sampling

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capacity. Similarly, disorders of consciousness can be viewed as situations in which the appropriate sample cannot be achieved and the consequent failure to adapt results from behaviour determined by this inadequate sampling. Many psychological symptoms of "organic deficit" can be viewed in this way. However, the danger in such an analogy is that one may think of the operation of dynamic consciousness purely in conventional perceptual terms, i.e. as being solely determined by the environmental cues.

The model of consciousness would of course involve the conventional afferent-efferent dimension, but would add the significant central regulatory mechanism which can produce activation in the absence of an input (i.e. other than interoceptive). As with all biological regulating systems equilibrium is achieved by balancing counter-forces—in this case the activation from perceptual input and the inherent activation of the brain-stem reticular apparatus. This apparatus is capable at one and the same time of alerting the system appropriately in response to stimulation and of balancing the input to the state of alerting achieved. This is consistent with the philosophical interpretation that consciousness represents what we are aware of and also the conditions for our awareness.

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